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ABSTRACT

This document, composed of 3 separated papers under 1 cover, is a case study of 1 institution's attempt to develop a system to permit optimum utilization of limited resources. The part of the system discussed here assumes that the institution has already made the decisions as to what it can do well and has to some extent allocated such resources as faculty, facilities, and money to these programs. The next step is to attract and select those students who will best utilize the resources as they are currently allocated. The primary focus of the 3 papers is on the fiscal elements of this system. (Author/HS)

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A Case Study in Institutional Planning

Presented at the
National Forum on New Planning
and Management Practices in Higher Education

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Introduction

This presentation is a composite of three different papers. The section dealing with the projection system was written by Eric Brown, the section on the "Parental Income Scale" by Everard Nicholson, and the perturbation analysis of the financial effects of increased enrollment by Paul Maeder.

We would like to thank Dr. Frances E. Dunn, Director of the Office of Educational Measurement, Miss Celeste Griffin, Mrs. Elaine Horsfield, and Mrs. Wei-Chi Chen Huo for their assistance in providing the data to make this project possible and Mrs. Joan Alexander who put up with our editing, re-editing and table changes.

This paper is a case study of one institution's attempt to develop a system to permit optimum utilization of limited resources. Although the system is designed for use at Brown University, it is hoped that some of the research findings and procedures can prove useful to a wide variety of colleges and universities faced with similar problems.

The method derives from the assumption that a private educational institution cannot be all things to all men. If the institution is to survive, it must concentrate on certain parts of the educational spectrum. In these areas, it must attempt to optimize its resources to offer first-rate educational programs.

The part of the system which will be discussed in the symposium assumes that the institution has already made the decisions as to what it can do well and has to some extent allocated its resources - faculty, facilities, and dollars to these programs. The next step is to attract and select those students who will best utilize the resources as they are currently allocated. There are a number of parameters imposed upon the selection process, e.g. academic standards, available scholarship funds, commitments to minority groups, alumni sons, athletes, etc. The objective therefore is to design a system which determines the best possible mix of entering students, subject to given constraints, which will optimize the distribution of resources. The primary focus of the three papers,which have been integrated for this presentation, is on the fiscal elements of this system.

If an institution is to select the class which will optimize the institution's resources as they are now allocated, the first step must be to ascertain whether or not it is possible to project with a reasonable degree of certainty the resource requirements of any given combination of applicants during their academic career. As the projections ultimately may be made prior to acceptance or matriculation, they must be based on information available in the applicant's admission credentials.

The rationale for the development of such a projection system is based on two hypotheses. The first is that the set of factors within an institution which influence students' course selection change gradually and in a discernible pattern. This set of factors which would include faculty, teaching methods, curriculum, peer group, etc. shall be referred to in the future as "institutional press".

The second hypothesis is that students, prior to entrance to college, already have characteristics which have a substantial and predictable influence over their course selection.

If hypothesis 1 is correct, then we can treat the "institutional press" as a constant over short-run periods and base projections on a relationship existing between student characteristics and course selection. The development of a projection system using this approach would make it possible to determine at or before entrance course selections and resources required for a four-year period for any given class.

To test the first hypothesis, student course selections had to be organized in such a way that meaningful inter-year comparisons could be made. Thus, both the aggregate of the student concentrations and the course selections were broken down into the four basic areas: Humanities, Social Sciences, Physical Sciences, and Life Sciences. All courses for all Humanities concentrators in the classes graduated in 1968-1970 were sorted into each of the four major areas. The same procedure was followed for Physical Science, Life Science, and Social Science concentrators. If "institutional press" changed significantly during the six-year period (from 1964 when the graduating class of 1968 entered, to 1970 when the last class graduated) it would affect the distribution of courses in one or more of the concentration areas. (Non-graduates were also included as a separate category as these students utilize a significant amount of the institution's resources.) Table 1 indicates the distribution of each of the five groups for the graduating classes of 1968-1970.

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Table 1

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Two conclusions can be drawn from this table. First, each area of concentration - Humanities, Social Sciences, etc. - differs significantly in the resources required to support that area. Second, the inter-year shifts in course distribution within each area are minor in magnitude. (A more detailed chi-square analysis of these three-year course patterns was carried in an earlier study which indicates the lack of significant change within concentration patterns by area, by department, and even by year - freshman, sophomore, etc. - within specific department concentration (Griffin and Brown, 1971).

However, to be of significant value in resource projections, we need to examine the stability of course selection patterns further. Table 2 contains the distribution of courses for each area of concentration by year, by course level, and by Department/ Groups of Departments.

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Table 2

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Again, in all three categories (by year, by level, and by department) the marked contrast between course selection patterns of the group of students who end up majoring in each area can be seen. Conversely, the hypothesis of stability within each area between years is supported by the analysis in Table 2. (It should

be noted that the students in all three of these classes were not required to declare concentration until the end of the sophomore year and A.B. Degree recipients - about 85% of all graduates in these classes-had no prescribed courses in the freshman and sophomore year with the exception of English Composition which was required of the classes of 1968 and 1969.)

With the demonstrated stability of the course patterns within area of concentration, it is now possible to examine the relationship of pre-entrance characteristics to ultimate area of concentration. Expressed area of academic interest was selected as one characteristic and sex of student as the second. Matrices of interest by academic discipline and ultimate area of concentration were then constructed for men and women for the classes entering Brown in 1963-1966. An example of a segment of the matrix is found in Table 3.

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Table 3

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Probabilities for a student with each interest ending up as a concentrator in each department were then constructed for each class. An example of a segment of the probability matrix is found in Table 4.

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Table 4

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The probabilities for the four preceding classes were used to derive the projections of group membership in each area of concentration and for non-graduates based on the interests and sex of the entering class of 1967. Table 5 contains a comparison of the projected versus actual numbers in each category.

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Table 5

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Of the 1090 graduating students, only 34 were projected in the wrong concentration pattern. This small degree of error plus the stability of the four-year course selection patterns within area of concentration provides the evidence to support the use of this approach in assessing the effects on the institution of admitting different combinations of students.

Of equal value is the possibility of using this projection system as a means of evaluating curriculum changes. The changes in curriculum should become apparent through a comparison of projected to actual. Two and one-half years ago, major changes were introduced in the curricular structure of Brown University. (Of the three graduating classes 1968-1970, only 1970 was affected.) By using projections based solely on pre-new curriculum classes, and contrasting them with actual classes under the new curriculum, we can see where changes are taking place and examine these

changes to ascertain whether or not they are in keeping with the new curricular objectives. Conversely, for projection purposes, the course selection patterns and probabilities can be continually updated to provide the most accurate base for projections to ascertain the effects of admitting alternative mixes of students. (N.B. Even in the instance where the institution has little or no selectivity in admission, this approach may be of value in assessing the resources needed by an entering class or the effects of changes of "institutional press".)

However, in each alternative mix of acceptable candidates, there are some students who can afford the cost of their education and some who cannot. Therefore, an added dimension to the decision making would be a means of ascertaining the ability to pay tuition for each of these mixes which leads us to the second element of this case study, parental earned income.

The decision of the Office of Analysis & Plans of Brown University to develop scales of estimated earned income arose from a wish to examine the concept that private colleges like Brown may be headed toward a situation where the student body will consist of rich and poor, the traditional middle class having been eliminated. As the research proceeded, it became clear that an instrument could be created with potential far beyond the original intention, providing a valuable tool for resource planning. Further, such a scale would be valuable to other offices such as admission, financial aid, and development.

Distributions of income are by no means new to planners. As part of its ongoing longitudinal research program, the American Council on Education regularly gathers family income data from college freshmen and makes available normative data based upon the samples of participating colleges. As useful as these distributions may be, they fall short of planning needs by virtue of the nature of the data - students' estimates. Experience at Brown University has revealed deliberate inflations of low income on the one hand and underestimation of higher incomes on the other. The most important aspect, however, is that ACE distributions of family income are restricted to matriculants, and does not include the total pool of applicants for admission.

Although any candidate pool can be described in terms of abilities, achievements and other characteristics, for about 60% who do not apply for financial aid, the vital description of individual ability to pay the sizeable amounts of money that a college education entails today is not available. On the premise that private colleges may not wish to ask for such information, but knowledge of upper income levels is necessary to determine policy for increasing tuition to offset increasing costs, it seems sensible to seek an indirect means of assessment.

A first attempt to derive income estimates making use of students' self-estimates was abandoned due to their unreliability. A second approach, that of predicting expected income by way of the multiple regression analysis model using socio-economic items and a crude scale derived from census data was also abandoned.

The chosen method became that of attaching an amount of money to a job. The most desirable norms would be those fitting parents of undergraduates, appropriate to a population about 40-50 years of age. Scales derived from Consumer Income Reports of the United States Department of Commerce were found to be both too limited and too low. Civil Service Scales were finally chosen as a starting point. Calibrated by level and years of service, it was possible to match positions and levels to derive estimates of earned income for those similarly employed in the federal service. Surveys were also made of professional and labor associations at all levels. The sets of information were combined to derive a scale of point data indicating typical income of occupational groups by level and sometimes by sex for executive, professional, managerial, clerical and worker occupations, stratified according to the supervisory, journeyman or self-employed nature of the work, and, for executives only, the size of the firm.

Each number in the scale categorizes the occupation, level and income assignment and has a standard deviation. Means of

categories were normalized by dividing all by the least, resulting in ordered codes which were algebraic in nature. Although amounts of income may be expected to change, it is reasonable to assume that rank orderings will not vary appreciably from year to year. Conversion to amounts of money, therefore, may take inflation into account but the scale does not have to be revised every year. Examples illustrate - data taken from applications for admission:

309 (S.D.=23): father is a top echelon executive in a large known firm.

121 (S.D.=18): his wife is a college professor but not a head of department or dean.

Not everyone within a profession has the same salary. A program has been written to redistribute all categories, as it were a real-life situation making use of the standard deviation. Fifty percent are assigned the face amount and 25% plus or minus one standard deviation. The redistributed amounts are summed within the same program to derive coded estimated family earned incomes. A second program distributes these within intervals, which, for purposes of comparison, are the same as those adopted by the American Council on Education (ACE: 1970).

For the above example, a range of $63,018 - $76,302 is derived. The scale itself ranges from presidents of large firms to categories of no earned income, such as unskilled, unemployed labor.

It has been noted that about 40% of Brown's candidate pool seek financial aid. Parents are required to submit information through the College Scholarship Service, outputs of which include family earned income. This became the criterion for validating amounts derived from the scale. The two sets of data were correlated using the sample of all men and women of Brown University who entered September, 1970 and sought financial aid (N=461) and replicated upon the identically similar sample of Tufts University who entered September, 1971 (N=315). Correlations of .77 and .71 between real and estimated data were found. The latter coefficient needs to be examined knowing that the data collector had but a few minutes of instruction, a manual, and absence of knowledge of the amounts of money associated with the categories. She was merely asked to fit parental occupations from information of job and title found in admission credentials of each student to codes in the scale.

The second procedure was to distribute reported and estimated family earned incomes for the same samples of those who sought financial aid. The results are found for both Brown and Tufts in the first two columns of Tables 6 and 7 respectively. In both cases differences between means of real and estimated data were nonsignificant.

Estimates were also derived for those who did not seek financial aid, and their distributions are also found in Tables 6 and 7. Validly, they describe considerably more affluent groups, less than 7% having family earned incomes less than $12,500 and about 25% or more in excess of $35,000 per annum.

It is assumed that reported family incomes are superior than estimated data. For studies of income only, therefore, combined data are recommended. Distributions of combinations of real data for those who applied for financial aid and estimated data for those who did not are found in Tables 6 and 7. They may be compared with national norms of students' estimates found in Table 8.

A novel means of tapping information concerning parental occupations and job titles, usually found in the credentials of applicants for college admission was proposed. From such information it was found possible to derive estimates of earned income as well as to classify occupations by type and level. Ranking and normalizing the data obviated the need to revise such scales annually and eliminated the problem of inflation. Correlations of .77(N=461) and .71(N=315) between real and estimated data were found for independent samples from two Northeastern colleges, as well as statistically similar means and sensibly similar distributions.

Making use of such estimates could lead to better understanding of the economic consequences of changes of university policy with respect to sizes of departments, degree and concentration enrollments, and so forth. Shifts and projections could be examined with greater insight into fiscal planning. It has been shown that accurate projections of the candidate pool can be made from a sample of current applications as early as October 15 at Brown University. Thus it is possible, using such an income scale, to project the parental income distribution of the total applicant group early in the fall. If it is necessary for an institution to have a large proportion of its applicants with no financial need, and if projections using this scale indicate that this will not occur, then there would still be ample time to change recruiting policies to bring the final pool into balance.

New insights into the problems of students' fees may be possible, the potential for raising them on the one hand and the consequences of increased financial need on the other.

If it becomes necessary to pay as much attention to candidates from homes with upper incomes as is now paid to those from lower incomes, then such a scale or a better one will be needed. On the other hand, state universities may be interested in the affluence of the total candidate pool to assist policy making with respect to fee structure. Should fees of state institutions be staggered? Such a scale as this provides one way of examining ability to pay within the total candidate pool. One Northeastern

regional state university is interested in the concept that it draws upon a population much less affluent than the state as a whole. A president with substantial information in hand is better able to take his case to the legislature.

Income distributions of total applicant groups, those who matriculate, withdraw before or after decision or who are rejected could give new direction to the admission process. Visualization of socio-economic differences between fine groups and trends from year to year cannot rise above the hunch level without objective data. A parental income variable adds a new dimension.

The scale is designed not only to indicate amounts of money but also to identify parental occupations and status, making possible the capture of specific occupational groups, sons of engineers for the engineering school, sons of medical practitioners for the medical program, for example, or attention to the whole spectrum from sons and daughters of top executives to lowly skilled and unemployed.

Clearly, such a scale is a socio-economic index. It has been found to be correlated with the Environmental Index locally created from biographical items for a Ford Foundation sponsored Brown University study of admission criteria (Nicholson, 1970). Not only may such a scale help better to describe the nature of a student body and its subgroups but also it may provide insights in the examination of dropouts, course selection patterns, and other studies of attrition, aspiration and achievement.

Brown's development office has found use in the estimates as a means of identifying donor groups. Potentially, the scale itself may be adjusted up and down for different ages to provide a valuable indicator of potential giving. On the other hand, the scale does not attempt to measure sophisticated incomes, but it does categorize, and a development office can proceed from there.

The third element of this presentation draws primarily from data in the previously described projection system in the first section. It is the purpose of this element to assess the financial changes that would occur were the undergraduate student body at Brown University increased without changing the quality of our instructional programs significantly. In our attempt to accomplish this we compute the incremental costs of students added to our undergraduate student body for three different types of students; the student who is representative of the average interest of our entering class, the student who indicates at entrance a special interest in the Physical Sciences, and the student who indicates a special interest in the Humanities.

Operating costs of academic departments are the largest single item in the cost of our educational programs. Therefore, the undergraduate enrollments per full-time equivalent faculty member in a given department is chosen as the indicator of faculty load above which an increase in enrollment will require a proportionate increase in faculty and below which it is assumed that excess teaching capacity is available and no faculty increase need be made. This parameter is carried through the analysis as the independent variable. Thus, the results are

obtained in terms of a course enrollment per faculty limit beyond which further increases in enrollment will require enlargement of certain departments.

The operating expenditures of the University are divided into four groups:

1) expenditures which can be expected to increase proportional to undergraduate enrollment (Dean's Office, Admissions Office, Student Services, etc.)

2) expenditures which are not expected to increase due to increased undergraduate enrollment (President's Office, Development, General Institutional, etc.)

3) expenditures which are expected to increase proportionate to increases in faculty size (Libraries, Instructional and Administrative building, etc.)

4) expenditures in the academic department from general funds. These are assumed to increase together with the faculty of the department proportional to enrollment increases in a department if the department's load is already at or above a certain limit.

It must be pointed out that the study is carried out as an incremental or perturbation analysis. Therefore its results apply only to relatively small increases or decreases (up to 10 or 20%) and cannot be used as an indicator for actual cost of education as they would be obtained from an analysis of programs (undergraduate programs, graduate programs, research programs, etc.). Once significant changes have taken place, cost distributions and other factors must be re-computed.

It is a basic assumption of this study that all the programs in an academic department (undergraduate, graduate, research) will increase proportionately if the department's faculty is increased. Thus, the study does not take into account or attempt to assess possible shifts from graduate to undergraduate instruction except in those departments where enrollment increases without faculty increases are to be achieved.

It is conceivable that a faculty increase in a department caused by an increase in undergraduate enrollment could result in income to the University beyond the tuition income of the undergraduate student. A faculty member might engage in sponsored research which would permit him to employ graduate students as research assistants which, in turn, would produce tuition income from these assistants to the Graduate School. No such possible increases have been taken into account.

Wherever there was a question with regard to allocation of costs or other assumptions - and there were many - the more conservative path was followed.

Finally, it should be pointed out that it is in the nature of such studies as the present one that, while they go into considerable detail department by department and cost item by cost item in their analysis, they should enter the decision-making process only in an overall and general fashion to determine objectives. Detailed decisions should be made only after much more scrutiny and analysis which takes into account many other factors. For instance, this study indicates that net revenues of approximately $1100 per additional student not on financial aid would be produced were the faculty increased only in those departments which now have course enrollments of more than 100 per faculty member. If one then should decide to proceed with a program to increase the enrollment, one should use the detailed information of this study as a rough guide only and carefully analyze these and other departments to determine whether a faculty increase is indeed justified or not justified respectively in a particular department.

PROCEDURE

Based on our records of the University's operation in fiscal year 1971, undergraduate enrollments, numbers of full-time equivalent faculty, and expenditures from general funds were determined for each academic department. The ratio of undergraduate enrollments to full-time equivalent faculty was then computed and chosen as the principal indicator for faculty load. It is realized that in many cases this may well present a somewhat distorted picture since departments may be carrying a smaller or larger graduate student body or research effort. However, it is the simplest number that can be derived without additional assumptions, and it is expected that no serious overall errors are introduced because some of these other factors in fact average out for the University as a whole.

In Table 9 the departments are listed in descending order for this faculty load factor. Faculty full-time equivalents and departmental expenditures are normalized with respect to total faculty and total departmental expenditures respectively. Thus, Department number 7 has 6.85% of Brown's faculty and spent 6.54% of the University's appropriation to instructional departments, while it carries 12.3% of the University's total undergraduate enrollments.

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Table 9

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Also listed in Table 9 are ratios for the Physical Sciences and the Humanities. These are the ratios of the probability that a student entering with this special interest chooses his courses in a particular department's area to the probability that an average student at Brown, no matter what his interest, chooces a course in the same department. These ratios have been determined from the enrollment records of the classes which graduated in 1968, 1969, and 1970. They are used to determine what enrollment changes would occur in the various departments if additional students with a particular interest were admitted. A more detailed analysis would calculate these ratios department-by-department rather than area-by-area. However, it is again felt that the error introduced through our coarser analysis will be small.

In Figure 1 the distributions of enrollment versus the departments, ordered by faculty load, are presented. It is seen, for instance, that one-half the enrollments by all students are in departments which carry more than 115 enrollments per faculty member.

Figure 2 shows the distribution of faculty among departments ordered by faculty load. We see, for instance, that one-half of our faculty engaged in teaching all students teaches in departments whose load is less than 46 course enrollments per faculty member. The curves indicate the relative faculty increase to a relative student increase (α_F) required if departments above a

certain load shall remain at constant enrollment per faculty member ratios. Thus, a 10% increase in enrollment of students with distributed interests similar to our present student body would require a 3.1% increase in faculty if only departments which already have an enrollment-to-faculty ratio above 100 were allowed to increase.

Figure 3 contains similar information to Figure 2 but for departmental expenditures from general funds rather than faculty (α_E).

In Table 10 the line item budget as approved by the Corporation for the year 1971-72 is presented. For each line item an incremental allocation factor is determined. Some of the items are expected to grow proportionate to enrollment, some proportionate to departmental expenditures (α_E), some proportionate to the increase in faculty (α_F). From this, and the total amount expended per student based on our projected enrollment for next year, the incremental amount of expenditures and tuition income per enrollment is determined. Knowing this and the various factors as well as the average number of courses taken by a student, the incremental net income resulting from an additional student, with or without granting financial aid, can be determined. This final result is presented in Figure 4.

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Table 10

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RESULTS

The results of the study are summarized in Figure 4. Once the course enrollment per faculty ratio beyond which compensatory faculty increases and increases in departmental expenditures are expected if enrollments are to be increased, the net incremental income per additional student admitted can be read off on the left-hand scale if the student is not to receive financial aid, and on the right-hand scale if the student is to receive on the average the same financial aid as the present student body.

It is seen that if a faculty load cut-off ratio of 100 is chosen, an additional student admitted without regard to his particular interest will produce additional net income of $1130 if he does not require financial aid. Similarly a student with an interest in the Physical Sciences will produce a net income of $1460, and a student with an interest in the Humanities, a net income of $975. If such a student is to receive average financial aid, the figures are $390, $720, and $235 respectively.

Table 1

Percent Distribution* of Courses of All Concentrators
in each of the Four Academic Areas for the Classes of 1968, 1969, 1970

Year of Grad	Courses Taken	Humanities Concentrators			
		Humanities	Social Sciences	Physical Sciences	Life Sciences
1968	6723	69	17	8	6
1969	7096	69	17	7	7
1970	6422	69	17	7	6
		Social Sciences			
1968	10453	35	48	10	7
1969	10541	35	48	10	6
1970	9043	35	49	9	6
		Physical Sciences			
1968	4814	25	13	59	3
1969	5415	24	13	59	4
1970	5184	21	12	62	4
		Life Sciences			
1968	3058	30	15	19	35
1969	3243	28	16	21	35
1970	3772	29	16	20	36
		Non-Graduates			
1968	2187	47	20	24	9
1969	2191	49	19	24	8
1970	2094	51	22	18	9

*rounded to nearest percent

Table 2a

Percent Course Distribution* by Area for Concentrators in the Humanities, Social Sciences, Physical Sciences, & Life Sciences for each of the Undergraduate Years

Grad. Class	No. of Majors	Freshman Year				Sophomore Year				Junior Year				Senior Year			
	Humanities	H	SS	PS	LS	H	SS	PS	LS	H	SS	PS	LS	H	SS	PS	LS
1968	215	57	15	18	10	60	21	9	9	76	18	3	4	82	14	2	2
1969	227	60	16	14	10	59	21	10	10	76	16	3	4	80	14	3	3
1970	211	57	19	15	9	61	22	8	9	76	16	3	5	83	13	2	2
	Soc. Sci.																
1968	330	49	22	20	9	37	40	13	10	29	62	4	4	28	66	3	3
1969	334	49	23	21	7	35	43	12	11	31	60	5	4	27	64	5	4
1970	291	46	29	17	9	36	44	11	9	29	61	5	4	31	65	3	3
	Phys. Sci.																
1968	146	34	6	59	1	20	17	60	3	24	15	57	4	22	14	61	4
1969	164	34	8	56	2	21	16	59	4	21	15	60	5	21	14	60	6
1970	159	28	10	60	2	22	14	61	3	21	12	62	6	16	12	66	5
	Life Sci.																
1968	97	41	10	33	16	28	19	26	27	26	15	12	45	27	16	8	50
1969	101	43	10	33	14	26	18	27	28	21	21	13	45	22	16	10	53
1970	122	38	9	36	17	27	20	24	29	25	17	13	49	25	16	7	52

H = Humanities
SS = Social Sciences
PS = Physical Sciences
LS = Life Sciences

*rounded to nearest percent

Table 2b

Percentage Distribution* of Courses by Level & Area for Concentrators in the Humanities, Social Sciences, Physical Sciences & Life Sciences

Year of Grad	Area of Concentration	Courses 0-99 Lower Level				Courses 100-199 Upper Level				% of Total	
		H	SS	PS	LS	H	SS	PS	LS	Lower	Upper
1968	Humanities Concentrators	66	12	12	9	71	27	1	1	66	34
1969		64	13	12	10	74	23	1	1	62	38
1970		65	13	11	10	73	25	0	1	62	38
1968	Social Science Concentrators	47	26	16	11	19	79	1	1	60	40
1969		46	26	17	11	22	75	2	1	58	42
1970		45	29	15	11	23	75	1	1	57	43
1968	Physical Science Concentrators	28	11	57	4	15	21	62	2	73	27
1969		28	11	56	5	14	20	63	3	72	28
1970		25	10	60	5	16	19	62	4	70	30
1968	Life Science Concentrators	35	10	28	27	18	29	1	52	71	29
1969		32	9	29	31	21	32	3	44	72	28
1970		30	9	28	33	26	31	2	41	71	29

*rounded to nearest percent

Table 2c

Percent Distribution* of all Courses Taken by Humanities, Social Sciences, Physical Sciences & Life Sciences Concentrators by Department/Groups of Departments**

		HUMANITIES					SOCIAL SCIENCES					PHYSICAL SCIENCES				LIFE SCI	
Year of Grad.	Courses Taken by Humanities Concn'tors	Art	Class	Ling Comp. Lit. Mod. Lang	Engl	Philo Music Rel. Stud	Am Cv Educ Egypt Asian Hist	Econ	Hist	Poli Sci.	Soc Anth	Appl Math Math	Astro Geol Chem	Engin	Phys	Bio	Psyc
1968	6723	8	7	15	26	11	1	3	5	4	4	4	2	0	2	2	4
1969	7096	7	6	15	27	13	1	2	5	4	4	4	3	0	1	2	5
1970	6422	8	6	15	27	12	1	2	6	4	5	3	2	1	1	2	6
	Social Sciences																
1968	10453	4	3	8	13	7	1	9	14	16	7	5	3	1	1	2	5
1969	10541	3	3	8	13	8	1	10	12	16	8	6	2	1	1	1	5
1970	9043	3	2	9	13	8	2	8	14	15	9	5	3	1	1	1	5
	Physical Sciences																
1968	4814	2	2	7	8	5	0	6	2	2	2	21	9	22	7	1	2
1969	5415	2	2	7	7	5	0	6	2	3	2	22	10	20	7	2	2
1970	5184	2	1	7	6	5	0	5	2	2	2	21	9	23	9	2	2
	Life Sciences																
1968	3058	3	3	8	10	5	1	2	3	3	7	7	7	1	4	16	20
1969	3243	1	3	7	10	6	0	2	3	3	7	8	8	1	4	19	16
1970	3772	2	2	7	10	7	0	2	2	3	8	8	7	2	4	18	18

*rounded to nearest percent.

**excludes Naval & Air Science & Human Studies Courses.

Table 3

INTEREST__CONCENTRATION MATRIX OF 1968 MEN

INTEREST	AREA 1 HUMANITIES CONCENTRATION													
	AFAM	ART	CLASS	COLIT	ENGL	FREN	GER	HISP	HUMST	LING	MUSIC	PHILO	RELST	SLAV
AFAM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ART	0	2	1	0	0	0	0	0	0	0	0	0	0	0
CLASS	0	0	1	0	0	0	0	0	0	0	0	0	0	0
COLIT	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ENGL	0	0	0	0	16	0	0	1	0	0	0	0	0	0
FREN	0	0	0	0	0	2	0	0	0	0	0	0	0	0
GER	0	0	0	0	1	0	0	0	0	0	0	0	0	0
HISP	0	0	0	0	1	0	0	0	0	0	0	0	0	0
HUMST	0	0	0	0	0	0	0	1	0	0	0	0	0	0
LING	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MUSIC	0	0	0	0	0	0	0	0	0	1	0	0	0	0
PHILO	0	0	1	0	2	1	0	0	0	0	0	0	0	0
RELST	0	0	0	0	0	0	0	0	0	0	0	1	0	0
SLAV	0	0	0	0	0	0	0	0	0	0	0	0	0	0
H1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
H2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
H3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AREA	0	3	0	0	2	0	0	0	0	0	0	0	0	0
TOTAL	0	5	3	0	22	3	0	2	0	1	0	1	0	0
AMCIV	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ASIA	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ECON	0	0	2	0	6	0	0	0	0	0	0	1	0	1
HIST	0	0	2	0	1	0	1	0	0	0	0	0	0	0
IR	0	0	0	0	0	0	0	0	0	0	0	0	0	0
POSCI	0	0	1	0	6	0	0	0	0	0	0	0	0	1
SCANT	0	0	0	0	2	0	0	0	0	0	0	0	0	0
SS1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SS2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SS3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AREA	0	0	0	0	1	1	0	0	0	0	0	0	0	0
TOTAL	0	0	5	0	16	1	1	0	0	0	0	1	0	2

Table 4

INTEREST__CONCENTRATION MATRIX OF 1968 MEN

AREA 1 HUMANITIES CONCENTRATION PROBABILITIES

INTEREST	AFAM	ART	CLASS	COLIT	ENGL	FREN	GER	HISP	HUMST	LING	MUSIC	PHILO	RELST	SLAV
AFAM	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ART	0.0000	0.2857	0.1429	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
CLASS	0.0000	0.0000	0.5000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
COLIT	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ENGL	0.0000	0.0000	0.0000	0.0000	0.4000	0.0000	0.0000	0.0250	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
FREN	0.0000	0.0000	0.0000	0.0000	0.0000	0.6667	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
GER	0.0000	0.0000	0.0000	0.0000	0.5000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
HISP	0.0000	0.0000	0.0000	0.0000	0.5000	0.0000	0.0000	0.5000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
HUMST	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LING	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000
MUSIC	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000
PHILO	0.0000	0.0000	0.1250	0.0000	0.2500	0.1250	0.0000	0.0000	0.0000	0.0000	0.0000	0.1250	0.0000	0.0000
RELST	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000
SLAV	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
H1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
H2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
H3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
AREA	0.0000	0.5000	0.0000	0.0000	0.3333	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
TOTAL	0.0000	0.0694	0.0417	0.0000	0.3056	0.0417	0.0000	0.0278	0.0000	0.0139	0.0000	0.0139	0.0000	0.0000
AMCIV	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ASIA	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ECON	0.0000	0.0000	0.0426	0.0000	0.1277	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0213	0.0000	0.0213
HIST	0.0000	0.0000	0.0417	0.0000	0.0208	0.0000	0.0208	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
IR	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
POSCI	0.0000	0.0000	0.0238	0.0000	0.1429	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0238
SOANT	0.0000	0.0000	0.0000	0.0000	0.2857	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SS1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SS2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SS3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
AREA	0.0000	0.0000	0.0000	0.0000	0.3333	0.3333	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
TOTAL	0.0000	0.0000	0.0307	0.0000	0.0982	0.0061	0.0061	0.0000	0.0000	0.0000	0.0000	0.0061	0.0000	0.0123

Table 5

Concentration Projections for Area of Concentration for All Members of the Graduating Class of 1971 using "Least Square Method"[1]

Area of Concentration	Actual	Projected	Difference	% Error[2]
Humanities	272	269.22	3	1.10
Social Sciences	329	336.68	-8	2.43
Physical Sciences	183	188.85	-6	3.27
Life Sciences	145	131.34	14	9.65
Non-Graduates	161	163.78	3	1.86
Total	1090	1090.00	34[3]	3.11

[1] Projection based on interest/concentration probabilities for men graduates and non-graduates, and women graduates and non-graduates. Probabilities were derived for each sex using the classes graduating in 1967, 1968, 1969 and 1970.

[2] % Error = $\left(\frac{A - P}{A}\right)$ where A = Actual, P = Projected.

[3] Total Difference = Total number of students incorrectly predicted.

TABLE 6

BROWN UNIVERSITY - 1970
(Percents)

ACE Intervals	Real Income	Estimated Income from the Scale				Combined Income*
	All who sought Financial Aid	All who sought Financial Aid	All without Financial Need	Men	Women	Total Class
less than 4000	4.6	5.4	0.5	2.2	3.4	2.2
4000 - 5999	2.8	2.8	0.2	1.2	1.5	1.3
6000 - 7999	5.0	4.8	0.8	1.8	4.0	2.5
8000 - 9999	7.6	4.6	0.5	1.9	2.8	3.4
10000 - 12499	12.1	12.1	3.4	7.3	6.5	7.1
12500 - 14999	11.9	13.9	6.1	10.1	7.7	8.5
15000 - 19999	26.5	27.1	16.6	21.5	19.7	20.7
20000 - 24999	15.4	15.0	19.8	17.7	18.2	18.0
25000 - 29999	6.3	9.8	17.5	13.9	15.1	12.8
30000 - 34999	5.4	1.7	10.5	6.8	6.8	8.4
35000 - 39999	1.5	1.7	8.8	5.8	5.8	5.7
40000 or more	0.9	1.1	15.5	9.8	8.6	9.4
Count	461	461	640	776	325	1101
Mean	16726	16819	28006	23501	22897	
S.D.	7391	8032	12134	11991	11875	

Correlation between real and estimated income for the sample who sought financial aid (N = 461; r = .77)

*Distributions of real data for those with financial aid are combined with distributions of estimates for the remainder

TABLE 7

FAMILY EARNED INCOME DISTRIBUTIONS FOR TUFTS UNIVERSITY - 1971
(Percents)

ACE Intervals	Real Income	Estimated Income from the Scale				Combined Income*
	All who sought Financial Aid	All who sought Financial Aid	All without Financial Need	Men	Women	Total Class
less than 4000	4.4	7.0	1.6	3.5	3.4	2.8
4000 - 5999	3.5	1.6	0.5	1.2	0.5	1.7
6000 - 7999	6.3	5.1	0.4	2.9	0.8	3.0
8000 - 9999	5.7	5.4	2.4	3.5	3.4	4.0
10000 - 12499	12.7	10.8	1.7	6.0	3.4	6.5
12500 - 14999	12.7	11.8	6.2	8.5	7.6	9.7
15000 - 19999	23.2	22.2	16.2	19.4	16.9	18.5
20000 - 24999	16.8	17.1	18.0	17.5	17.9	16.2
25000 - 29999	7.3	10.5	15.5	13.2	14.5	11.9
30000 - 34999	4.1	4.1	11.6	8.4	9.8	8.3
35000 - 39999	1.6	2.5	13.1	8.9	10.0	8.9
40000 or more	1.6	1.9	12.8	7.0	11.6	8.5
Count	315	315	579	515	379	894
Mean	16872	17616	26999	22562	25272	23431
S.D.	7679	9232	11172	11047	11790	

Correlation between real and estimated income for the sample who sought financial aid (N = 315; r = .71)

*Distributions of real data for those with financial aid are combined with distributions of estimates for the remainder

TABLE 8

DISTRIBUTIONS OF SELF-ESTIMATED INCOME, CLASS OF 1974,
FOR PRIVATE UNIVERSITIES AND FOR PRINCETON UNIVERSITY

Income Interval	Private Universities			Princeton University		
	Men	Women	Total	Men	Women	Total
Less than 4000	2.6	2.9	2.7	2.6	0.6	2.2
4000 - 5999	3.8	4.6	4.1	2.9	3.2	2.9
6000 - 7999	6.7	7.1	6.9	4.0	5.8	4.3
8000 - 9999	10.2	9.4	9.9	4.7	6.5	5.0
10000 - 12499	15.9	13.6	15.0	9.6	3.2	8.5
12500 - 14999	14.4	12.6	13.7	10.0	9.7	10.0
15000 - 19999	15.8	14.7	15.4	16.8	9.7	15.5
20000 - 24999	10.3	11.4	10.7	13.6	19.4	14.7
25000 - 29999	5.5	6.4	5.9	8.0	8.4	8.1
30000 - 34999	3.7	5.4	4.4	5.3	7.7	5.8
35000 - 39999	2.4	3.3	2.8	3.2	4.5	3.4
40000 or more	8.7	8.4	8.6	19.2	21.3	19.6

NOTE: These norms were taken from National Norms for Entering College Freshmen--Fall 1970, American Council on Education, and Princeton Alumni Weekly, February 23, 1971.

Private Universities (non-sectarian) include all of the Ivy League except Brown and Yale.

TABLE 9

DEPARTMENT	AREA	UG/FTE	FTE/FTE_T	EXP/EXP_T	ENR/ENR_T	PHYS. SCI. - MATH RATIO	HUM. RATIO
1	H	150.5	.0126	.0150	.0266	.745	1.494
2	SS	148.8	.0253	.0187	.0530	.773	.884
3	LS	146.5	.0340	.0359	.0701	.657	.823
4	SS	142.2	.0348	.0354	.0696	.773	.884
5	SS	140.5	.0209	.0145	.0414	.773	.884
6	H	134.3	.0252	.0235	.0476	.745	1.494
7	H	127.7	.0685	.0654	.1231	.745	1.494
8	O	122.3	.0034	.0041	.0059	-	1.494
9	O	121.0	.0021	.0021	.0035	-	1.494
10	H	114.1	.0252	.0228	.0404	.745	1.494
11	SS	112.0	.0346	.0273	.0546	.773	.884
12	SS	110.5	.0266	.0306	.0414	.773	.884
13	SS	97.7	.0034	.0025	.0050	.773	.884
14	PS	81.7	.0540	.0436	.0621	1.399	.536
15	H	80.2	.0172	.0151	.0194	.745	1.494
16	H	77.8	.0251	.0191	.0274	.745	1.494
17	PS	69.8	.0354	.0608	.0348	2.116	.536
18	O	60.1	.0062	.0059	.0052	-	.884
19	H	47.2	.0252	.0201	.0167	.745	1.494
20	PS	45.5	.0247	.0274	.0158	2.116	.536
21	PS	44.3	.0889	.1030	.0554	2.116	.536
22	H	38.8	.0397	.0276	.0216	.745	1.494
23	H	38.3	.0220	.0143	.0113	.745	1.494
24	PS	33.7	.0625	.0537	.0296	2.116	.536
25	LS	32.4	.1363	.1415	.0621	.657	.823
26	PS	32.3	.0711	.0961	.0322	2.116	.536
27	H	27.8	.0199	.0173	.0078	.745	1.494
28	H	26.9	.0201	.0157	.0076	.745	1.494
29	SS	24.4	.0081	.0087	.0028	.773	.884
30	H	24.2	.0106	.0116	.0036	.745	1.494
31	SS	5.5	.0042	.0039	.0003	.773	.884
32	SS	2.0	.0042	.0065	.0001	.773	.884
33	O	-	.0063	.0052	.0000	-	-
TOTAL		71.1	1.0000	1.0000	1.0000		

TABLE 10

	Amount 71-72	Incremental Alloc. Factor	Amount Per U.E. 71-72*	Incrm. Amt. Per U.G.Enr.
ADM. & GENERAL:				
General Adm.	1,743,791	.191		
Student Service	1,257,884	1.0		
Dev., Alumni, P.R.	1,391,523	0.0		
General Inst.	836,022	0.0		
Total Adm. & General	5,229,220	.304	148.50	45.14
INSTRUCTION:				
Instr. Depts. & Univ. Res.	12,889,996	α_E		
Grant & Contract Res.	7,562,500	0.0		
Univ. Ext.	40,000	0.0		
Libraries & Museums	2,237,397	α_F		
Total Instr.	22,729,893	$.567\alpha_E+.098\alpha_F$	645.00	$\alpha_E 365.72 + \alpha_F 63.21$
INTERCOLL. ATHLETICS	741,367	0.0	21.06	
EDUC. PLANT OPERATIONS:				
Instr. & Adm. Buildings	2,139,630	α_F		
Libraries & Museums	423,990	α_F		
Athletic & Recr. Fac.	319,030	1.0		
General Grounds	136,025	0.0		
Security	375,000	.5		
Heating Plant & Office Bldg.	450,000	0.0		
Total Educ. Plant	3,843,675	$.666\alpha_F+.131$	109.20	$\alpha_F 72.73 + 14.30$
TOTAL EDUC. & GENERAL	32,544,155		924.00	$\alpha_E 365.72+\alpha_F 135.94 + 59.44$
STUDENT AID FROM GEN. FUNDS	3,209,000	$0 < B < 1$	91.10	B(91:10)
TUITION INCOME	12,286,350	1.0	349.00	349.00
NET INCOME				$289.56 - (365.72\alpha_E + 135.94\alpha_F + 91.10B)$

*Projected U.E. for 71-72 35,195; 4311 students.

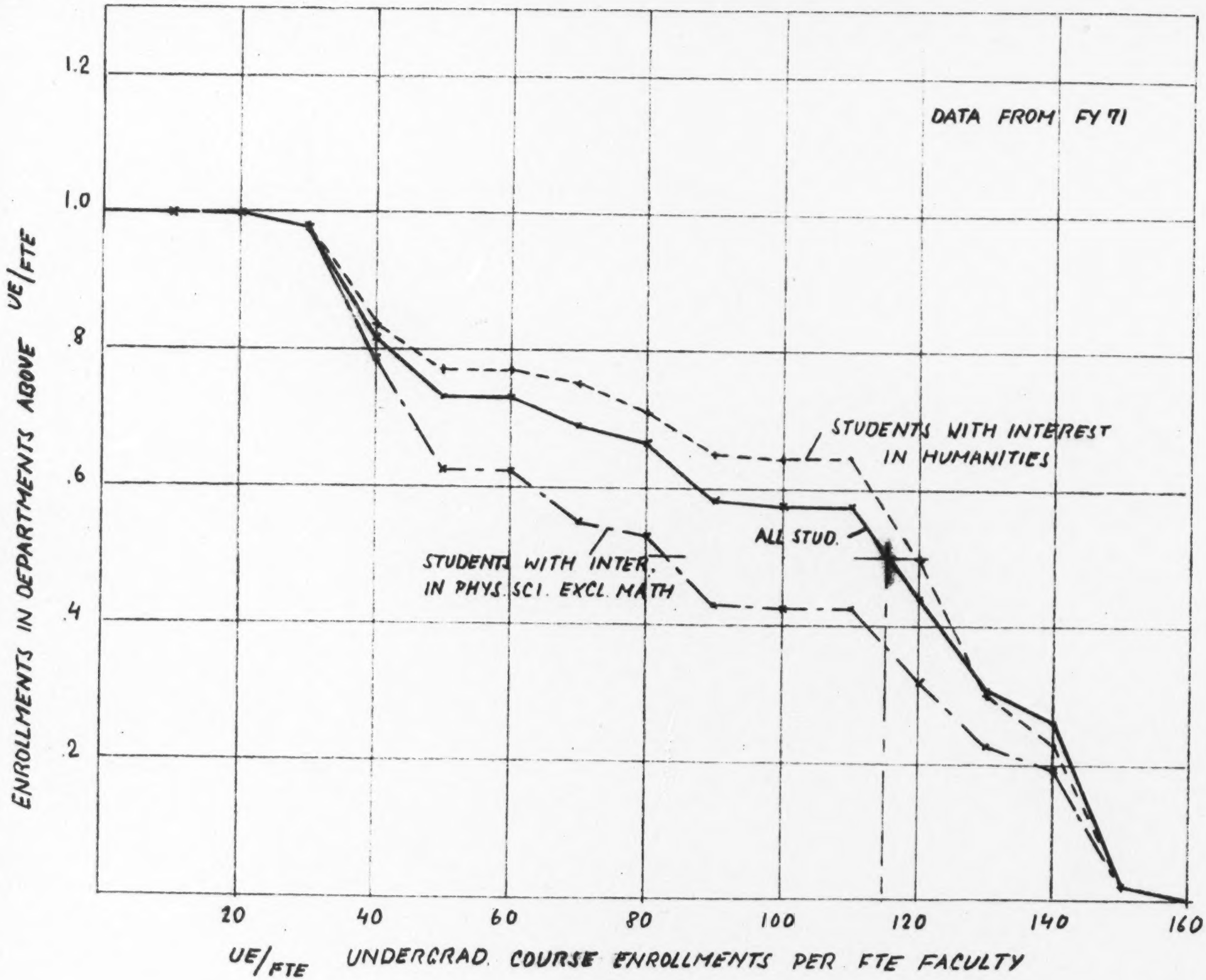
DATA FROM FY 71
STUDENTS WITH INTEREST IN HUMANITIES
ALL STUD.
STUDENTS WITH INTER. IN PHYS. SCI. EXCL. MATH
ENROLLMENTS IN OTHER DEPARTMENTS ABOVE UE/FTE
1.2
1.0
.8
.6
.4
.2
20
40
60
80
100
120
140
160
UE/FTE UNDERGRAD. COURSE ENROLLMENTS PER FTE FACULTY

FIG 1

7-20-71

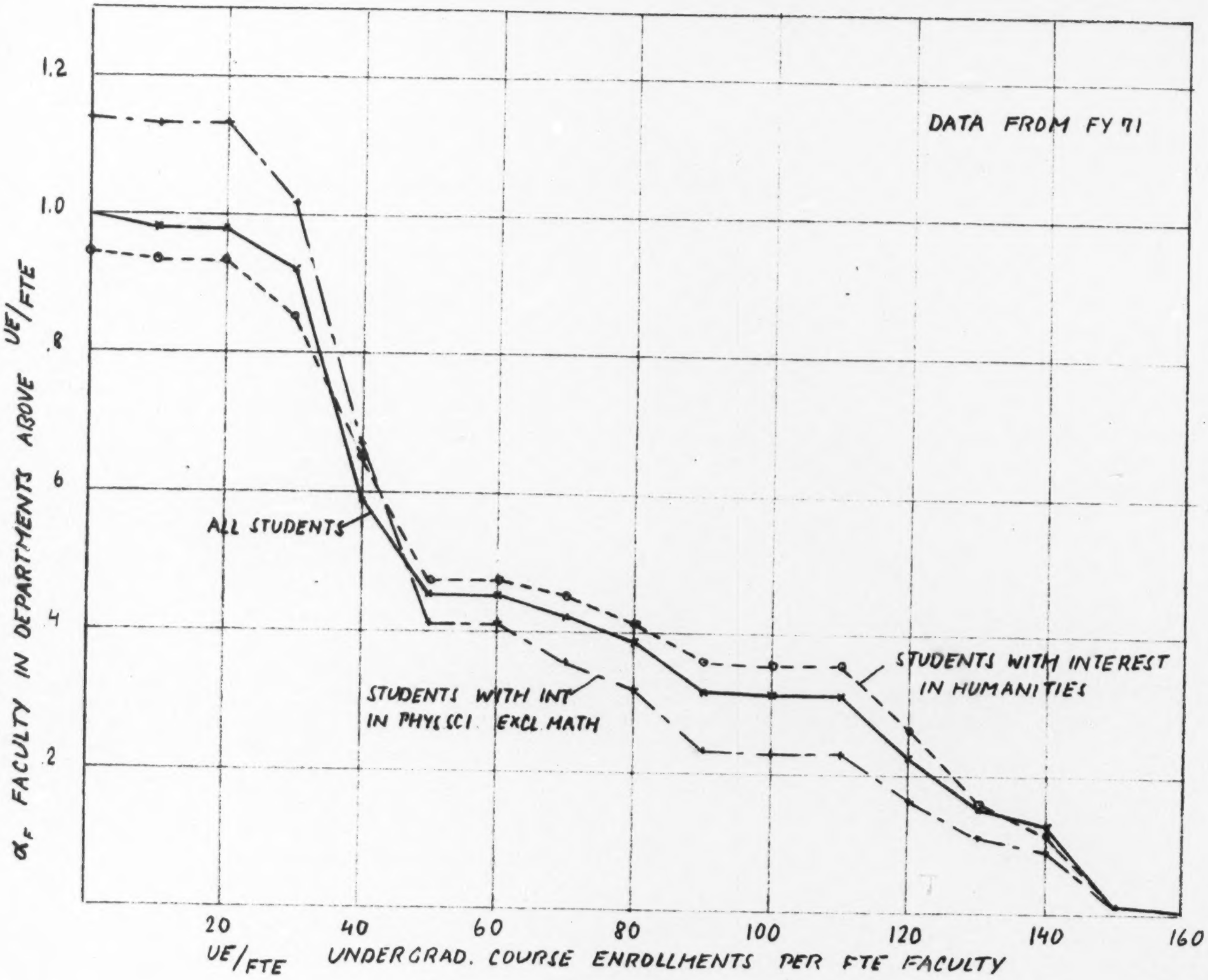
DATA FROM FY 71
1.2
1.0
.8
6
4
2
α_F FACULTY IN DEPARTMENTS ABOVE UE/FTE
ALL STUDENTS
STUDENTS WITH INT IN PHYS SCI EXCL MATH
STUDENTS WITH INTEREST IN HUMANITIES
20
40
60
80
100
120
140
160
UE/FTE UNDERGRAD. COURSE ENROLLMENTS PER FTE FACULTY

FIG. 2

7-30-71

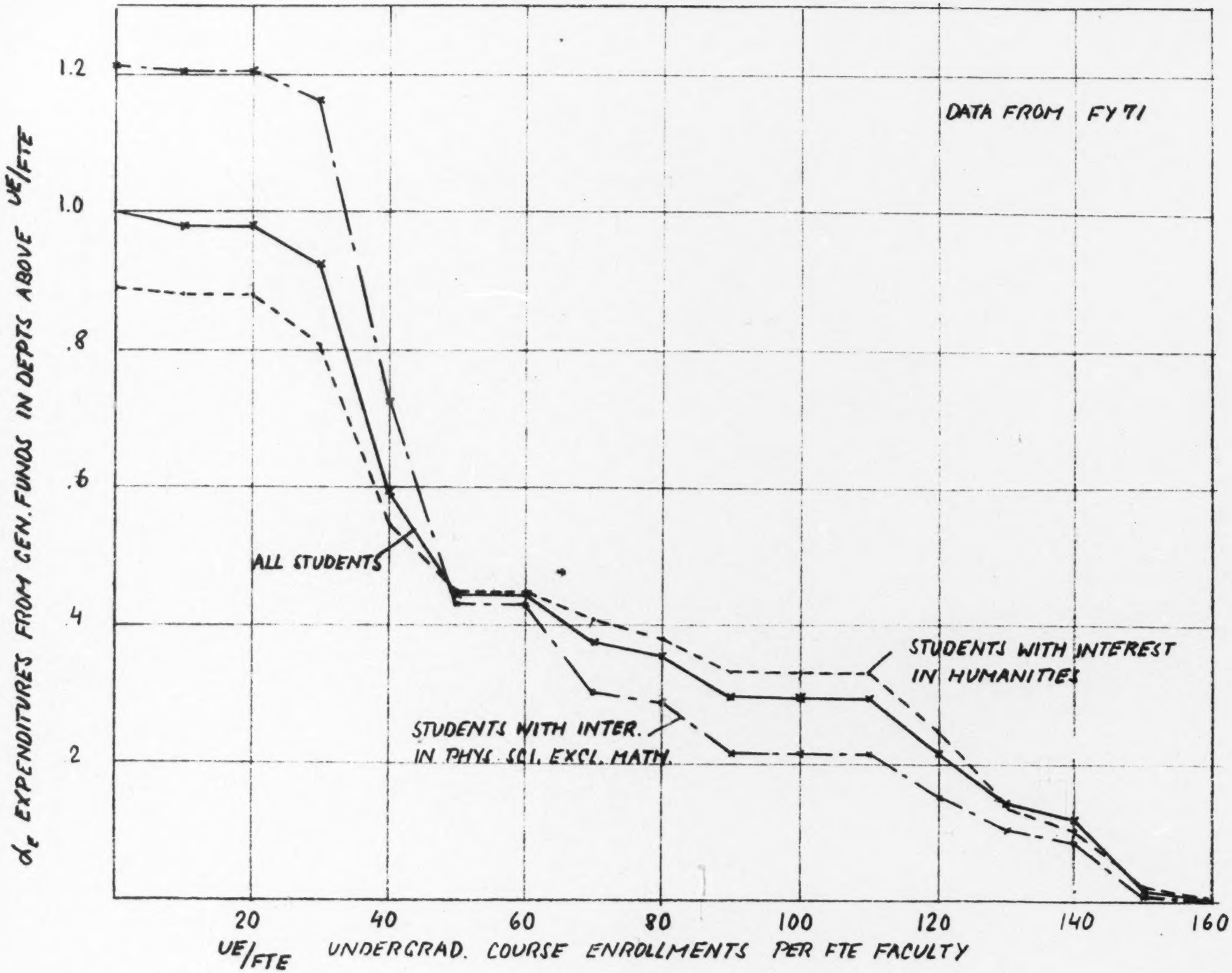
DATA FROM FY 71
ALL STUDENTS
STUDENTS WITH INTEREST IN HUMANITIES
STUDENTS WITH INTER. IN PHYS. SCI. EXCL. MATH.
1.2
1.0
.8
.6
.4
2
20
40
60
80
100
120
140
160
UE/FTE UNDERGRAD. COURSE ENROLLMENTS PER FTE FACULTY
d_e EXPENDITURES FROM GEN. FUNDS IN DEPTS ABOVE UE/FTE

FIG. 3

7-30-71

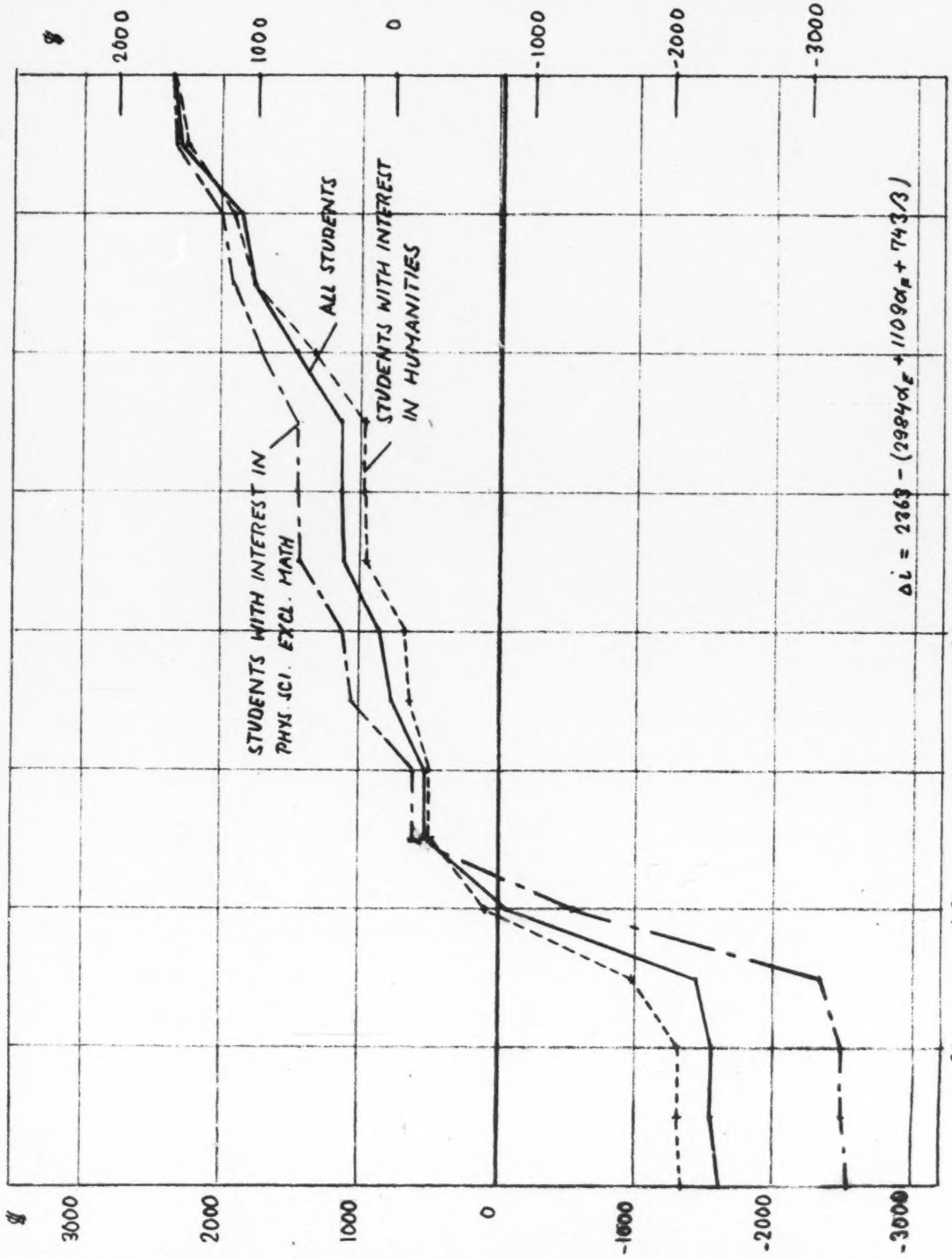
INCREMENTAL INCOME (EXPENDIT.) PER STUDENT, AVG. FIN AID
$
2000
1000
0
-1000
-2000
-3000
ALL STUDENTS
STUDENTS WITH INTEREST IN HUMANITIES
STUDENTS WITH INTEREST IN PHYS. SCI. EXCL. MATH
$\Delta i = 2363 - (2984\alpha_E + 1109\alpha_R + 743\beta)$
120
140
160
UE/FTE UNDERGRAD. COURSE ENROLLMENTS PER FTE FACULTY
7-22-71
INCREMENTAL INCOME (EXPENDIT.) PER STUDENT, NO FIN. AID
Δi
$
3000
2000
1000
0
-1000
-2000
-3000
20
40
60
80
100

FIG. 4

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